Title: It's Plane to See

Brief Overview:

In this unit students have the opportunity to identify and explore geometric solids and their properties by using plane figures as a foundation. The big mathematical ideas for these lessons are the third dimension of height and the use of plane figures to make solid figures. Throughout the unit, students analyze characteristics and properties of three-dimensional geometric shapes and create a data table about geometric relationships. Students use visualization, spatial reasoning, and geometric modeling to solve problems. Students construct various geometric solids using straws and marshmallows. The problem they investigate is: "In the real world, where will we find these shapes, and how are they used? Is there a reason one shape is used instead of another?"

NCTM Content Standard/National Science Education Standard:

Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships

Grade/Level:

Grade 2

Duration/Length:

3 days (60 minutes).

Student Outcomes:

Students will:

- Identify plane figures in solids
- Compare and contrast plane figures and solid figures
- Identify vertices, faces, and edges of cubes, rectangular prisms, and triangular prisms
- Apply knowledge of geometric shapes by identifying them in the real world and pictures

Materials and Resources:

Day 1

- Cube
- Square cut out of paper
- Overhead projector

- Triangular prism (per pair of students)
- Rectangular prism (per pair of students)
- Chart paper and markers
- Student Resource 1 (Pre-Assessment)
- Student Resource 2 (Venn Diagram) per pair of students, and one teacher transparency
- Student Resource 3 (Venn Diagram) per pair of students, and one teacher transparency
- Student Resource 4 (Assessment Exit Ticket)
- Teacher Resource 1 (Answer Key)
- Teacher Resource 2 as transparency
- Teacher Resource 3 (Answer Key)
- Teacher Resource 4 (Answer Key)
- Teacher Resource 5 (Key Vocabulary Terms) for transparency
- Teacher Resource 6 (Answer Key to Exit Ticket)
- 14 paper clips and 17 straws per student for those who pre-assess out of these lessons (see Differentiation)

Day 2

- Overhead projector
- Triangular prism, rectangular prism, cube
- Square cut out of paper with dimensions of a coffee stirrer
- Marshmallows (15/pair of students)
- Coffee stirrers (22 straws/pair of students)
- Construction paper, cut into standard paper size, 1/pair
- Labels (4/pair of students)
- Post-its
- 5 pieces of chart, each with a question written in advance of lesson (Teacher Resource 8)
- Student Resource 5 (Parts of a Solid)
- Student Resource 6 (Castle photo)
- Student Resource 7 (Castle photo)
- Teacher Resource 7 (Parts of a Solid Answer Key)

Day 3

- How a House is Built by Gail Gibbons (Paperback - Mar 1996)
- Student Resource 6 and 7
- Highlighter or thin marker
- Transparencies
- Teacher Resource 8

Development/Procedures:

Day 1

- o Pre-assessment
    - Distribute copies of Student Resource 1. Students have five minutes to complete the six questions.
    - Collect and assess current knowledge of the skill. Answer key can be found on Teacher Resource 1.
    - Students who show prior knowledge of content are offered an alternate activity. (See Differentiation)

- o Engagement
    - Teacher places square on overhead, hiding the shape from the students.
    - Students hypothesize what the object is.
    - Teacher then places a cube on the overhead, and again students hypothesize what the shape is.
    - Teacher guides discussion using questions such as
        - What can you tell us about the shapes?
        - How are these objects the same?
        - How are they different?
        - How do you know?
        - Do you know the name of this shape?
        - Where have you seen this shape before?
    - Teacher uses Teacher Resource 2 transparency to model how to compare and record similarities and differences of the cube and the square.

- o Exploration
    - Divide students into pairs, making sure each pair has a strong writer. Distribute Student Resource 2 or 3 to each pair.
    - Distribute the triangle and triangular prism to students with Student Resource 3, and the rectangle and rectangular prism to pairs with Student Resource 4.
    - Allow students to investigate all similarities and differences for 10 minutes.
    - Students who finish early may be offered the other shape and the other Venn diagram to investigate.

- o Explanation
    - Students share findings from their Venn diagrams, and teacher records a class set of ideas on the transparency of Student Resource 2 and 3.
    - Teacher guides students' discussion of differences and similarities by introducing key vocabulary (Teacher Resource 5).

- o Application
  - ▪ Teacher asks, "Where else have you seen these shapes?"
  - ▪ Teacher records student responses on chart paper, challenging students to identify at least 10.

- o Differentiation
  - ▪ Reteach:
    Teacher evaluates results of exit tickets (Student Resource 4) to target students who need reinforcement on Day 2.

  - ▪ Enrich:
    Students who show knowledge of this content on the pre-assessment work independently to investigate which shape has the strongest structural shape. Day one: Students use pattern blocks as models for the plane shapes. They use paper clips and straws to construct plane shapes, to determine which of the plane shapes is sturdiest, and will not bend or change shape with pressure. A *website* *http://www.pbs.org/wgbh/buildingbig/educator/act_straw_ho.html* *explains and directs this activity. Students rejoin the class discussion during the Application part of the lesson. When they have concluded their investigation (probably after several days), they should be permitted to share their findings, and their method of proof, to the class.*

    Students who quickly understand and accurately record similarities and differences of the first shape can explore and record observations on a second shape.

- o Assessment
  - ▪ Distribute Student Resource 4. Use results to determine which students need additional work with key vocabulary terms the next day.

Day 2

- o Engagement
  - ▪ Teacher shows one of the three shapes on the overhead. Teacher asks, "What shape is this? How do you know? Is it a part of a solid shape? How do we know?" Teacher needs to make sure that students who showed lack of knowledge on Student Resource 4 (Exit ticket) are clear about the difference between and plane figure and solid figure.
  - ▪ This discussion can continue with the other shapes.

- o Exploration/Explanation
  - Before the teacher begins this part of the lesson, he/she tells the students, "I need to build a cube. How would I begin? What shapes would I need? How many marshmallows and straws will I need?"
  - Teacher uses the Teacher Resource 5 (key vocabulary) to describe what he/she is doing as he/she builds edges, vertices, and faces. To demonstrate a face, use a square cut out of paper that is the same length and width of the straw. Have a student can draw a smiley face on the face of the square piece of paper. Then it will be inserted into the cube to represent a face.
  - Teacher creates a cube using marshmallows and coffee straws while using key vocabulary.
  - Distribute Student Resource 5 so that students can list the number of edges, vertices, and faces in a cube with teacher modeling on the overhead.

- o Application
  - Divide class into student pairs.
  - Assign half the student pairs to build a triangular prism and the other half to build a rectangular prism.
  - Teacher asks each pair to predict on a post-it how many marshmallows and straws they will use to build their solid figure.
  - Distribute fifteen marshmallows and twenty-two straws per pair and a triangular prism or rectangular prism to model.
  - Allow fifteen minutes to build their assigned solid figure and to complete Student Resource 5 for their assigned figure.

- o Differentiation

  - Differentiation
  - Reteach:
    Teacher circulates, guiding students who need reinforcement by demonstrating vocabulary with the cube model.

  - Enrich:

    Students who work independently on Day 1 complete only one of the shapes.They then predict the vertices, faces, and edges for the other shape on Student Resource 6.If time permits, they continue their investigation from Day1.

    Students who successfully complete their first shape should be offered an opportunity to build the other solid figure and complete

the chart. If time, students extend this activity by choosing a new solid figure to complete the blanks at the bottom of the chart.

- o Assessment
    - ▪ Distribute four labels per pair and a sheet of construction paper per pair.
    - ▪ Ask students to identify the parts of a solid figure by writing the terms on the label and putting them in the correct place.

Day 3
- o Engagement
    - ▪ Teacher reads aloud How a House Is Built.
    - ▪ Discussion includes open-ended questions such as
    - ▪ How can we use what we know about shapes to build things?
    - ▪ How are shapes used to build things?
    - ▪ What is the strongest (most common?) shape?
    - ▪ How do shapes grow?
    - ▪ What patterns can we find in shapes?

- o Exploration
    - ▪ Divide students into pairs.
    - ▪ Distribute Student Resource 6 and 7 and a highlighter or thin marker to each student pair.
    - ▪ Allow 10 minutes for students to identify and label plane and solid shapes on their photos.

- o Explanation/ Application
    - ▪ Students share their findings with the class.
    - ▪ Teacher groups students into five groups. Each group answers one of the five questions (Teacher Resource 8) written on chart paper.
    - ▪ Students share their findings on the chart paper in 10 minutes.

- o Differentiation
    - ▪ Reteach:
    - ▪ *Upon accurate completion of the castle activity, students from the independent group from Day 1 should be allowed to continue their investigation from Day 1. Because this investigation may not be completed in these three days, when students can be released from classroom instruction, they can complete the investigation. Students should report their findings before the end of the entire geometry unit.*

    - ▪ Enrich:

- If a student pair completes the activity successfully in advance of the other students, that pair can trace the shapes on a transparency to demonstrate their findings to the class.

Summative Assessment:

Students show knowledge of plane figures and solid figures by answering three selected responses and one brief constructed response Student Resource 8. Answers are on Teacher Resource 9.

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Preassessment – Solid Figures
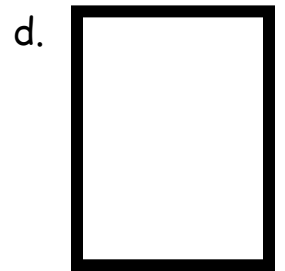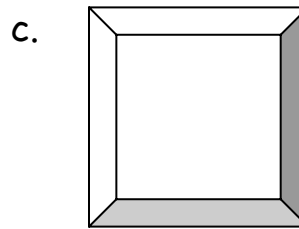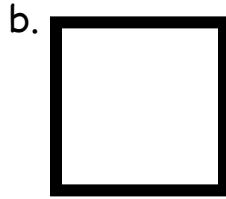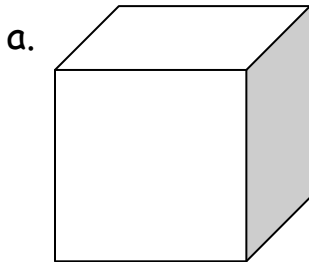
1. Circle the square.

a.   b.   c.   d.

2. Circle the rectangular prism.

a.   b.   c.   d.

3. Circle the triangular prism.

a.

b.

c.

d.
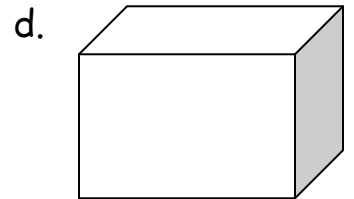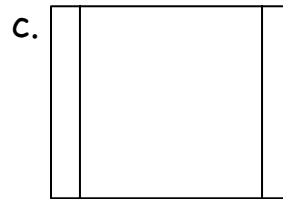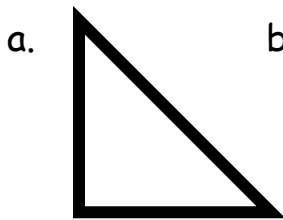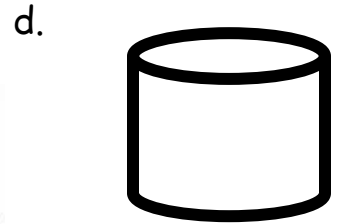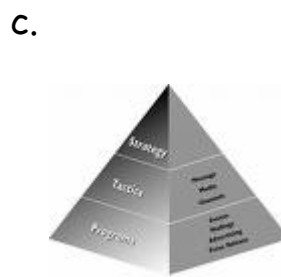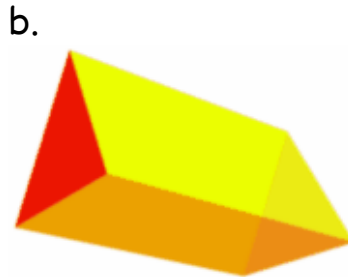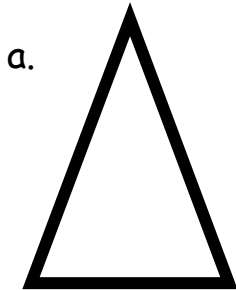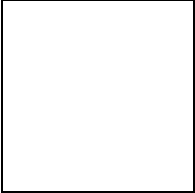
4. What do solid figures have that plane figures do not have?

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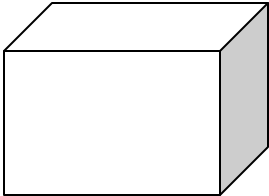
5. How many vertices does a cube have? _____

6. What do you know about shapes?

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Rectangle

Rectangular Prism

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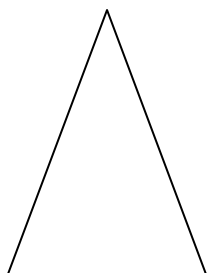
Triangle	Triangular Prism

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_____   _____

Exit Ticket
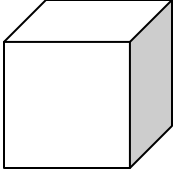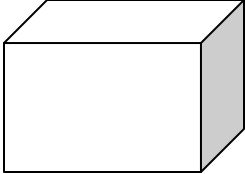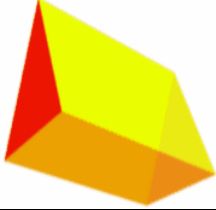
What is the difference between a plane figure and a solid figure? Use words and/or pictures to help explain.

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What new questions or ideas do you have?
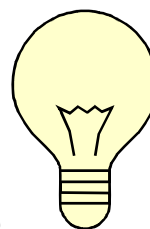
Name	Shape	Faces	Vertices	Edges
Cube				
Rectangular Prism				
Triangular Prism				

Karlstein castle was built in 1348 in Czechoslovakia, by Czech King and Roman Emperor Charles IV to keep the royal treasures, such as holy relics and the coronation jewels of the Roman Empire. http://www.hradkarlstejn.cz/home1/

There were once about 5000 castles in Japan, but today there are only about 50 left. You may have seen this castle as a ninja training school in movies or the TV miniseries, Shogun. Known as the "White Heron Castle", Himeji Castle was built in the 14th century, and rebuilt in 1580.

http://www.teachenglishinasia.net/asiablog/10-japanese-castles

It's Plane to See Assessment

1.   Label the parts of the solid figure below.
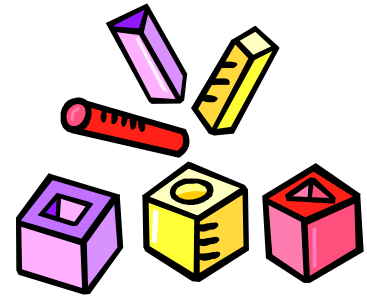
Name of figure _____

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2. Circle the plane figures.
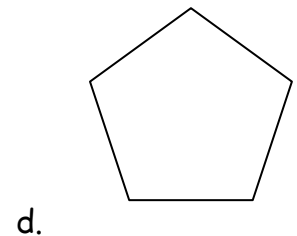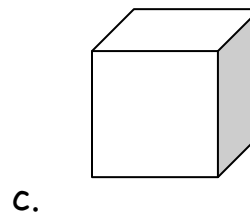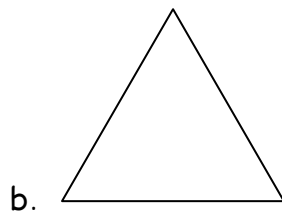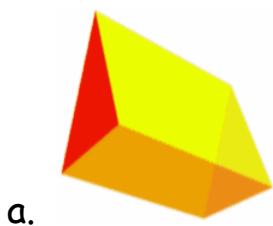
a.   b.   c.   d.

Brief Constructed Response

Identify a rectangular prism or triangular prism in the classroom or one that you know of in the real world. Explain all the things you know about it that shows you are right.
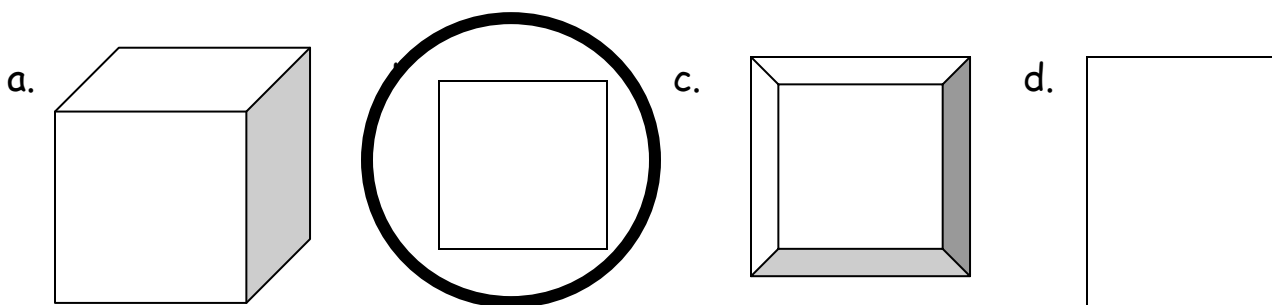
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Extra Credit

 You are a house builder for the three little pigs. You want them to build a house that will stand up to the wolf. Write a letter to convince them what shape it should be, and tell them why. Use geometry vocabulary!
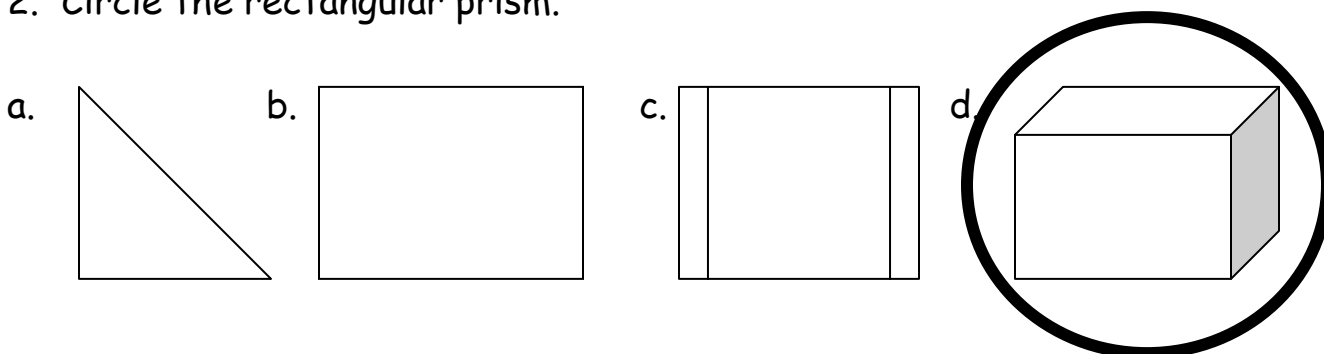
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Pre-assessment – Solid Figures

1. Circle the square.

a.   b.   c.   d.

2. Circle the rectangular prism.

a.   b.   c.   d.

3. Circle the triangular prism.
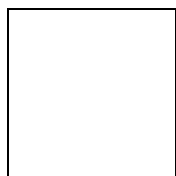
a.   b.   c.   d.
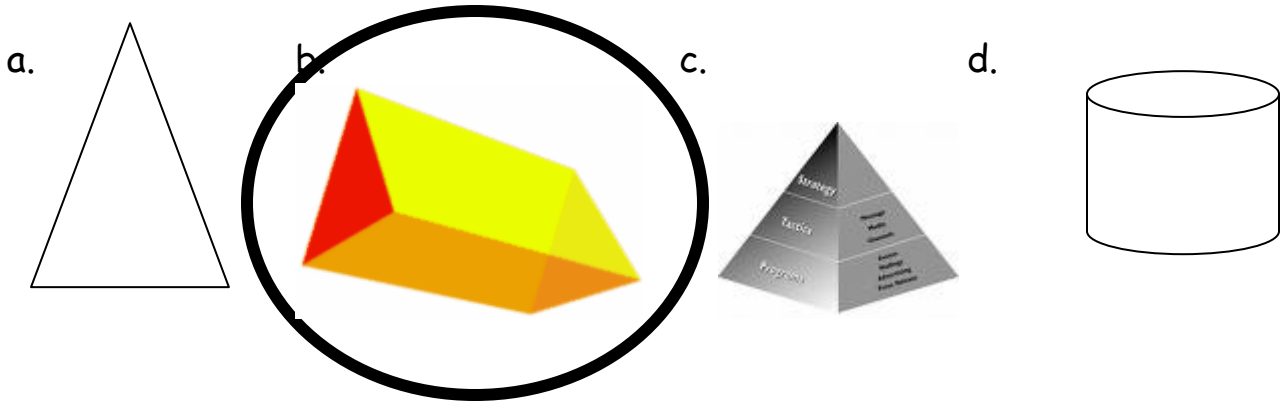
4. What do solid figures have that plane figures do not have?
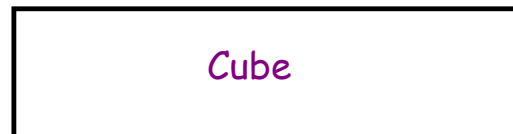   Solid figures have height or depth.

5. How many vertices does a cube have? 8
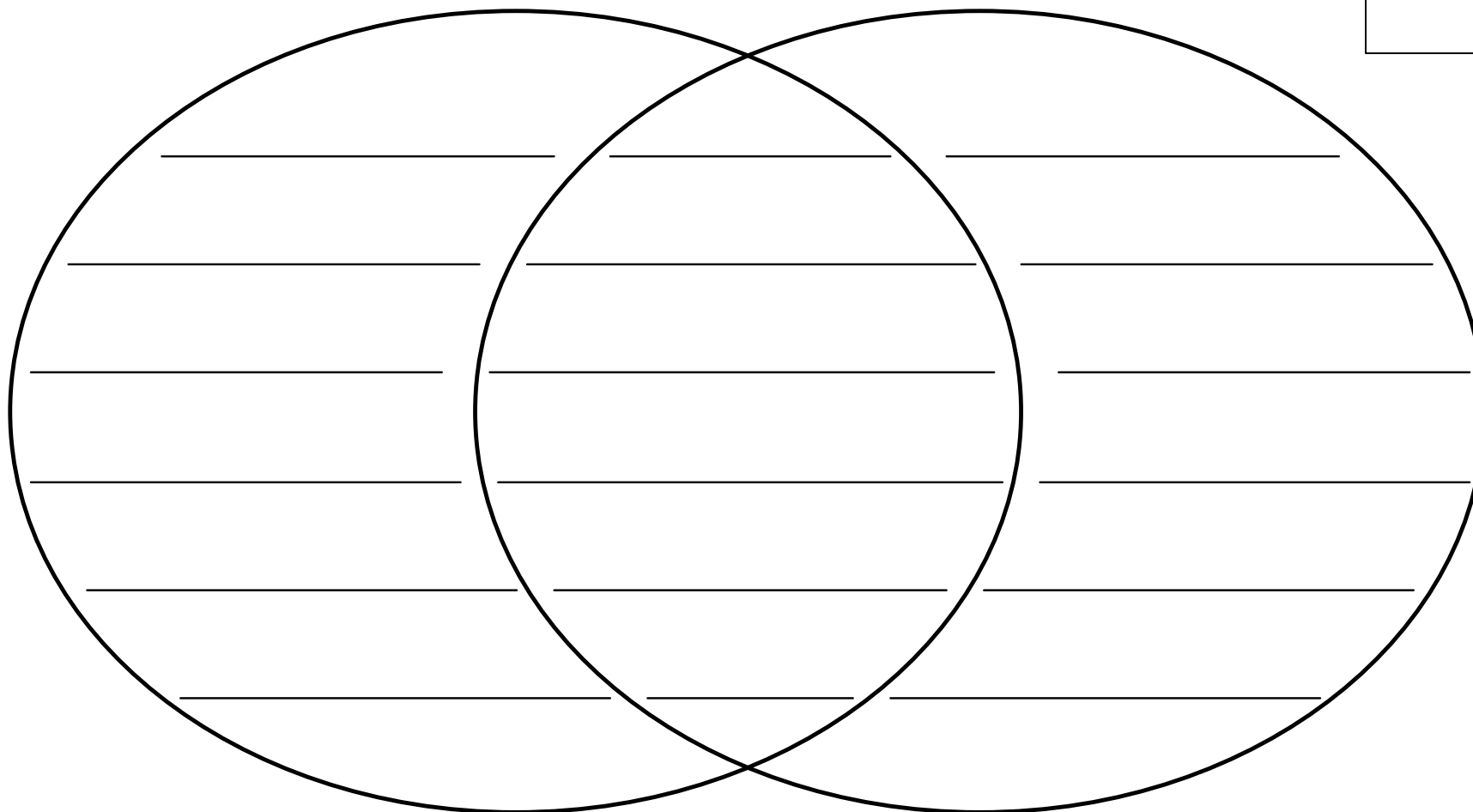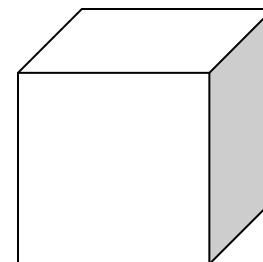
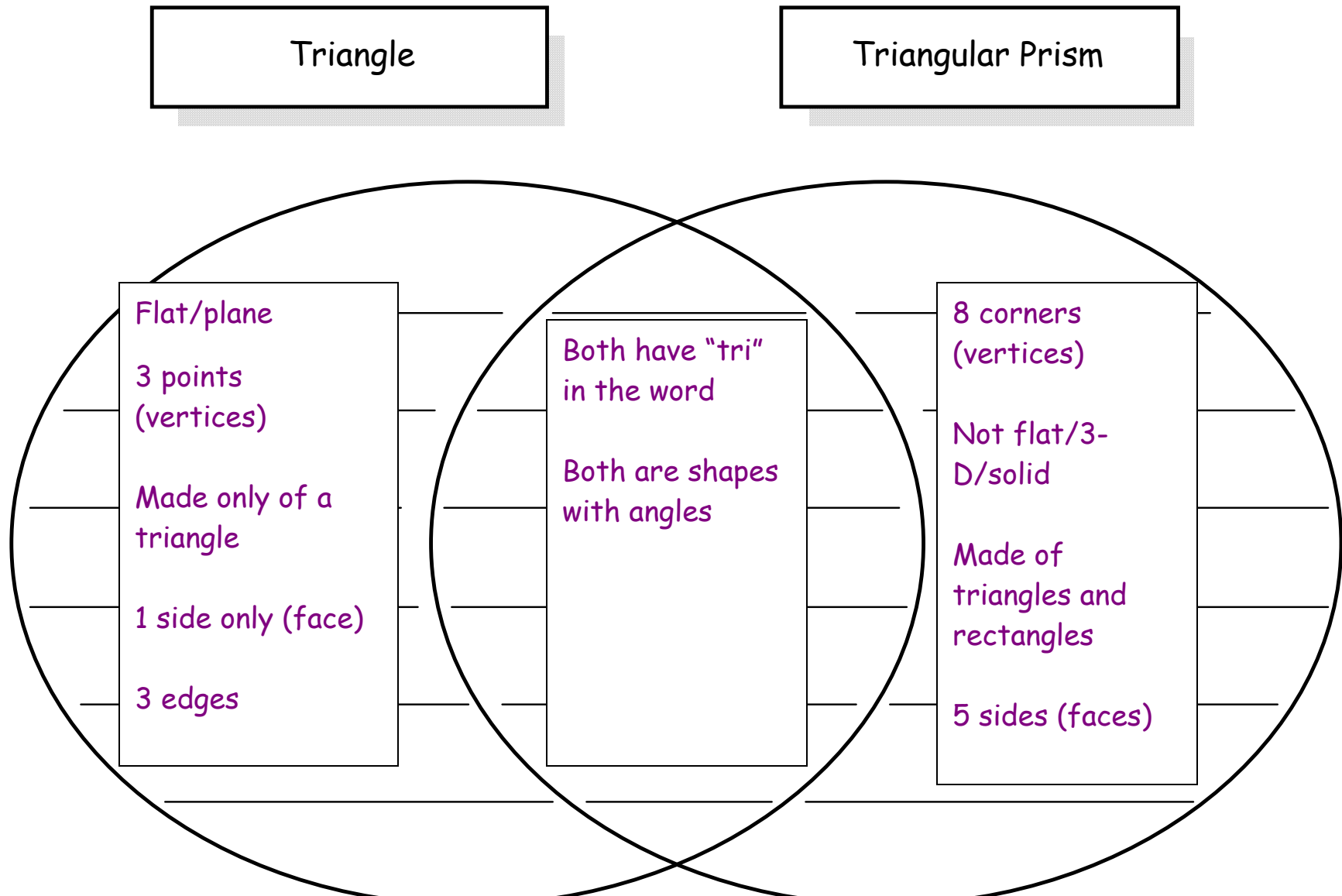6. What do you know about shapes?
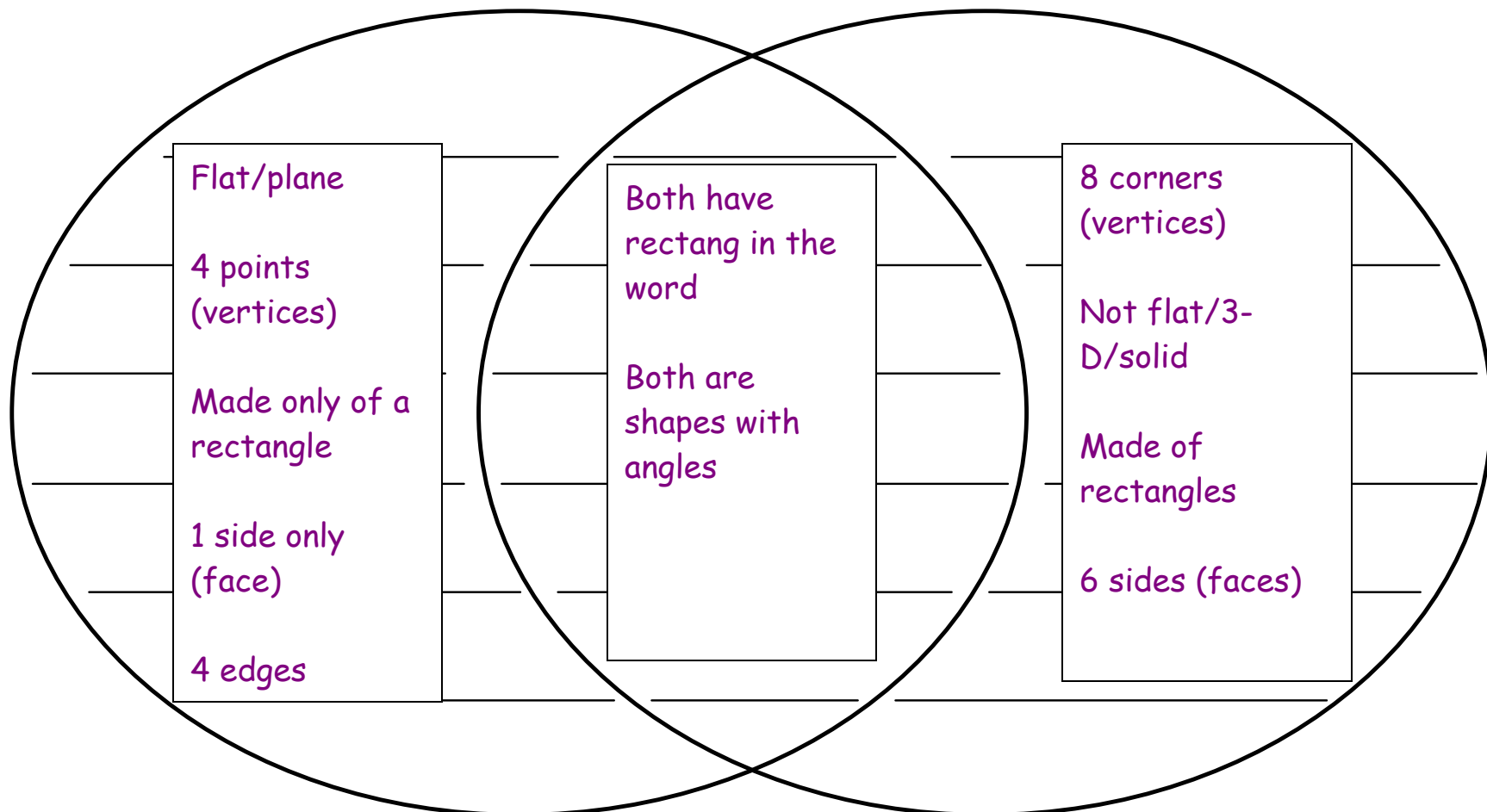   Answers will vary

Square

Cube

_____   _____   _____

_____   _____   _____

_____   _____   _____

_____   _____   _____

_____   _____   _____

_____   _____   _____

Triangle	Triangular Prism

Flat/plane

3 points (vertices)

Made only of a triangle

1 side only (face)

3 edges

Both have "tri" in the word

Both are shapes with angles

8 corners (vertices)

Not flat/3-D/solid

Made of triangles and rectangles

5 sides (faces)

Students' answers may vary.

| Rectangle | Rectangular Prism |

Flat/plane

4 points (vertices)

Made only of a rectangle

1 side only (face)

4 edges

Both have rectang in the word

Both are shapes with angles

8 corners (vertices)

Not flat/3-D/solid

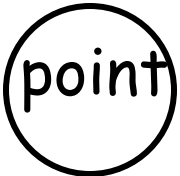Made of rectangles

6 sides (faces)

Students' answers may vary.

Key Vocabulary Terms for Geometry

Plane figure: A flat shape

Solid figure: A shape that has length, width, and height

Vertex: The (point) where two lines meet

Edges: The sides of a plane or a solid figure that connect the vertices

Face: A flat side of a solid figure

Exit Ticket

What is the difference between a plane figure and a solid figure? Use words and/or pictures to help explain.
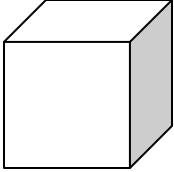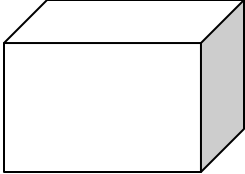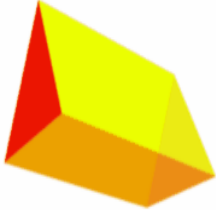
The difference between a plane figure and a solid figure is that the plane figure is flat, and the solid is made up of many plane figures. A plane figure has vertices, one face, and edges. A solid figure as many vertices, faces, and edges. (Answers may vary in terminology.)
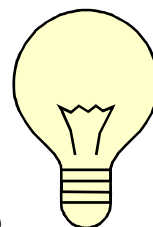
What new questions or ideas do you have?

Parts of a Solid Figure – Do You See a Pattern?

Name	Shape	Faces	Vertices	Edges
Cube		6	8	12
Rectangular Prism		6	8	12
Triangular Prism		5	6	9

How are plane figures and solids different?

What are some plane and solid figures in and around your classroom?

In how many different ways can we describe a toy wagon using geometric words?

What are your favorite plane and solid figures? Why?

What shapes are harder to find in buildings and around you? Why do you think that is so?

[Shapes with right angles are easier to construct and therefore more common in buildings. Circular shapes and shapes without right angles (pentagons, hexagons, heptagons, etc.) are less common.]

It's Plane to See Assessment
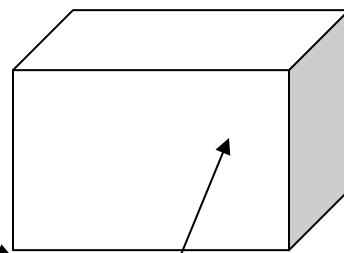
1. Label the parts of the solid figure below.
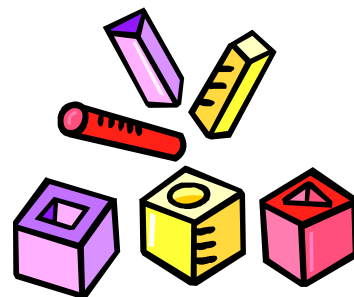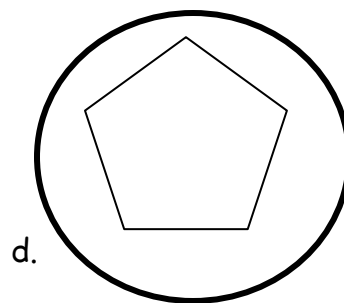
Name of figure ___rectangular prism
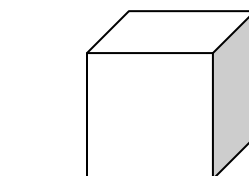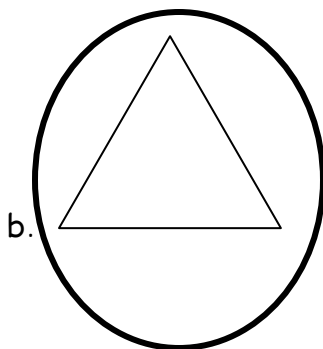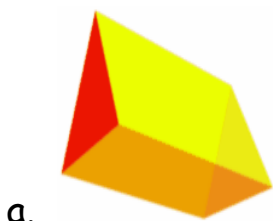
___vertex _____

_____edge_____

_____face_____

2. Circle the plane figures.

a.   b.   c.   d.

3. Brief Constructed Response

Identify a rectangular prism or triangular prism in the classroom or one that you know of in the real world. Explain all the things you know about it that shows you are right.

(Answers will vary.) Rectangular prisms should include 8 vertices, 12 edges, and 6 faces. Triangular prisms should include 5 faces, six vertices and nine edges.

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Extra Credit
 You are a house builder for the three little pigs. You want them to build a house that will stand up to the wolf. Write a letter to convince them what shape it should be, and tell them why. Use geometry vocabulary!

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